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**(54) Projection Display Apparatus**

(57) A projection display apparatus contains a discharge lamp, a detector which detects the lamp energy of the discharge lamp on the basis of predetermined information, and a controller. The controller controls the discharge lamp on the basis of the detection result of the detector in order to change the energy of the lamp.

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## Description

### BACKGROUND OF THE INVENTION

#### 1. Field of the Invention

The present invention relates in general to a projection display apparatus, in particular to a projection display apparatus which employs a discharge lamp.

#### 2. Description of Employed Technology

Metal halogenide lamps are generally often used with projection display apparatuses in which a discharge lamp is employed. As the metal halogenide lamp has a certain operational lifetime, the metal halogenide lamp will gradually deteriorate when it is used. When the metal halogenide lamp has been used for 1,000 to 2,000 hours, the illumination intensity stability factor will normally deteriorate by 10 to 50%. That is why a metal halogenide lamp is treated as a consumable part that is subject to wear and tear and must be replaced in certain time intervals.

The conditions influencing the deterioration of the metal halogenide lamp can be roughly divided into the following deterioration condition categories listed below from (a) through (c).

During deterioration belonging to condition (a), the glass tube of the halogenide lamp becomes deformed due to deterioration of the strength of the glass and since the gas inside the glass tube is released outside, emission of light is no longer possible.

On the other hand, during deterioration belonging to condition (b), a non-transparent section is produced on the inner wall of the glass tube as a result of the deterioration of the glass tube and the temperature of the non-transparent section is increased as a result of light absorption by the non-transparent section. For this reason, the distribution of the temperature inside the glass tube will change during the deterioration belonging to condition (b) and the arch discharge becomes unstable, which will produce so called flickering.

Moreover, the deterioration belonging to condition (b) also destroys a particularly weak section of the glass tube, which will cause an explosion of the glass tube.

During deterioration belonging to condition (a), the metal halogenide lamp will simply die and there is no danger to the user. However, during deterioration belonging to condition (b), the display quality of the projection display apparatus will be deteriorated to a great extent and this deterioration condition (b) can in the end lead to deterioration condition (c). Moreover, during deterioration belonging to condition (c), fragments of the glass tube and

gas such as mercury become dispersed when the glass lamp cracks and this can create a danger for the user. In addition, the user can become scared or disturbed by the noise of the explosion which is caused when the glass tube explodes.

Therefore, conventional projection display apparatuses suffered from problems wherein the characteristics of the display lamp could suddenly become noticeably deteriorated, or in an extreme case, so that the glass tube of the discharge lamp could explode.

### SUMMARY OF THE INVENTION

The general task of the present invention is therefore to provide a novel and useful projection display apparatus in which the above described problems are eliminated.

Another specific goal of the present invention is to provide a projection display apparatus comprising a discharge lamp, and a detector which detects the lamp energy of the discharge lamp on the basis of predetermined information and which controls the discharge lamp on the basis of a detection result in order to change the lamp energy. According to the projection display apparatus of the present invention it is possible to prevent definitively a sudden, noticeable deterioration of the characteristics of the discharge lamp, or in an extreme case, to prevent definitively an explosion of a glass tube of the discharge lamp. It is additionally also possible to provide an indication for the user of the projection display apparatus that the end of the operational lifetime of the discharge lamp has been almost reached, whereby the lamp energy is gradually reduced in order to create a gradually darker screen.

Other goals and other characteristics of the present invention will become apparent from the detailed description below, in connection with the enclosed drawings.

### BRIEF DESCRIPTION OF THE DRAWINGS

**Fig. 1** is a perspective view which shows a first embodiment of a projection display apparatus according to the present invention;

**Fig. 2** is a diagram which shows an important part of an optical unit of the first embodiment;

**Fig. 3** is a system block diagram which shows an important part of the first embodiment,

**Fig. 4** is a flowchart explaining the operation of the first embodiment;

**Fig. 5** is a diagram which shows data that are stored in ROM in the first embodiment;

**Fig. 6** is a system block diagram which shows an important part of a second embodiment of the projection display apparatus according to the present invention;

**Fig. 7** is a flowchart explaining the operation of the second embodiment;

**Fig. 8** is a diagram which shows the data that are stored in ROM in the second embodiment;

**Fig. 9** is a system block diagram which shows an important part of a third embodiment of the projection display apparatus according to the present invention,

**Fig. 10** is a flowchart explaining the operation of the third embodiment;

**Fig. 11** is a system block diagram which shows an important part of a fourth embodiment of the projection display apparatus according to the present invention;

**Fig. 12** is a flowchart explaining the operation of the fourth embodiment;

**Fig. 13** is a diagram which shows the data that are stored in the fourth embodiment;

**Fig. 14** is a system block diagram which shows an important part of a fifth embodiment of the projection display apparatus according to the present invention;

**Fig. 15** is a system block diagram which shows an important part of a sixth embodiment of the projection display apparatus according to the present invention;

**Fig. 16** is a diagram which shows the basic construction of the sixth embodiment; and

**Fig. 17** is a diagram showing the mechanism of a lamp cooling part of the sixth embodiment.

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#### DESCRIPTION OF PREFERRED EMBODIMENTS

**Fig. 1** is a perspective view which shows the first embodiment of a projection display apparatus according to the present invention. **Fig. 2** is a diagram showing an important part of an optical unit of the first embodiment.

As shown in **Fig. 1**, the projection display apparatus contains generally a optical unit **22** and a light source **23**, which are deployed on a base **21** and provided with a ventilator **24**, mounted on a light source **23**. As one can see from **Fig. 1**, an exhaustor **25** and a power supply **26** are deployed inside the optical unit **22**, wherein the side surface section of the optical unit **22** is omitted in the illustration so that the inner part of the optical unit **22** is visible.

As shown in Fig. 2, the optical unit 22 generally contains an ultraviolet/infrared (UV/IR) filter 2, total reflection mirrors M1 and M2, a condenser lens 3, a liquid crystal panel unit 4, dichroitic mirrors DM1 through DM4 and a projection lens 5. An optical path from the liquid source 23 to the liquid crystal panel unit 4, as well as an optical path from the liquid crystal panel unit 4 to the projection lens 5, is determined and provided with different lengths.

The light source 23 contains a discharge lamp such as for example a metal halogenide lamp. The heat, which is produced inside the projection display apparatus when such an apparatus emits light from a discharge lamp, is dissipated with the ventilators 24 and 25. The power supply 26 supplies power voltage to the different parts deployed inside the projection display apparatus.

The basic construction is naturally not limited only to the projection display apparatus which is shown in Fig. 1 and 2 and the present invention can be applied to various known basic constructions in which a discharge lamp is used.

Fig. 3 is a system block diagram which shows an important part of the first embodiment. In Fig. 3, a lamp power supply 26-1 contains inside a power supply 26 an input part 261, a switch 262, a monitoring part 263, a power regulation part 264, a power determination part 265 and an igniter 266. In addition it also contains a controller part 31 provided with a microcomputer part 32 and with a counter of the accumulated lamps ON time 33.

The microcomputer part 32 is provided with a known construction including a microcomputer which comprises a processor such as a CPU, and a memory such as ROM and RAM memory. In this embodiment, the controller part 31 controls the metal halogenide lamp 23a within the light source 23.

The input part 261 supplies voltage to the monitoring part 263 through the switch 262 to turn the lamp 23a on. The voltage from the monitoring part 263 is supplied to the lamp 23a through the igniter 266. The monitoring part 263 monitors the lamp power which is supplied to the igniter 266 and supplies the monitored lamp power to the power regulation part 264. The lamp power, which depends on the accumulated lamps ON time, is indicated by the controller part 31 to the power determination part 265, and the power regulation part 264 in order to adjust the power of the lamps depending on the monitored lamp power. The power regulation part 264 controls the switch 262 depending on the control that is exercised by the power determination part 265 so as to reduce the lamp power when this is required.

The counter of the accumulated lamps ON time 33 counts the accumulated lamps ON time, that is to say the accumulated time during which the lamp 23a is ON, or always when the lamp 23a is turned on. The count value obtained from the counter of the accumulated lamps ON time 33 is supplied to the microcomputer part 32. When the count value of the counter of the accumulated lamps ON time 33 reaches for example 700 hours, the microcomputer part 32 determines a lamp power of 320 W for the power determination part 265 on the basis of this count value. Based on the lamp power of 320 W, determined by the

power determination part 265, the power regulation 264 is controlled by the switch 262 in such a way so that the lamp power, which is monitored by the monitoring part 262, is reduced from 350 W to 320 W. When the count value of the counter of the accumulated lamps ON time 33 reaches 900 hours, the microcomputer part 32 will determine in a similar manner a lamp power of 290 W on the basis of this count value for the power determination part 265 and on the basis of this lamp power of 290 W, the power regulation part 264 will control the switch 262 so that the lamp power, which is monitored by the monitoring part 263, will be reduced to from 320 W to 290 W. When the count value of the counter of the accumulated lamps ON time 33 further reaches 1,000 hours, the microcomputer 32 will determine based on this count value a lamp power of 250 W for the power determination part 265 and on the basis of this lamp power of 250 W, the power regulation part 264 will control the switch 262 in such a way that the lamp power, which is monitored by the monitoring part 263, will be reduced from 290 W to 250 W.

This regulation of the switch 262 makes it possible to reduce the voltage and/or current of the lamps, so that the power of the lamps is decreased. For example, the lamp current is approximately 5.5 A when the lamp power is 350 W, and the lamp current will be about 3.9 A when the lamp power is 250 W.

Fig. 4 is a flowchart explaining the operation of the first embodiment. As shown in Fig. 4, the count value of the counter is reset during step S1 to 0 and the whole number N is set to  $N = 1$  when the projection display apparatus is shipped from a plant or when the lamp 23a is replaced. When the user turns the main power of the projection display apparatus ON during step S2, the data which has been stored in the ROM of the microcomputer part 32 will be read during step S3 into the microcomputer 32.

For example, let us assume that data is stored in the ROM of the microcomputer 32 as shown in Fig. 5. In this operation mode #1, the ON time will be adjusted to 0 and the lamp power will be adjusted to 350 W as shown in Fig. 5. In addition, if during the operation mode #2, the ON time is set to 700 hours and the lamp power is set to 320 W, during operation mode #3, the ON time is set to 900 hours and the lamp power 290 W, and during the operation mode #4, the ON time is set to 1,000 hours and the lamp power is set to 250 W.

During step S4, the microcomputer is set to the standby state, and during step S5 it will be determined whether the ON/OFF switch of the projection display apparatus was or was not activated. If the result of the determination during step S5 is NO, the process is returned to step S4. On the other hand, if the result of the determination is YES, the lamp power supply part 26-1 will be controlled during step S6 in order to turn lamp 23a ON with the lamp power (350 W in this case) of the operation mode # ( $N + 1$ ), which will also cause the count value of the counter of the accumulated lamps ON time 33 to be counted upward from the ON time value 0.

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During step S7, it will be determined whether the monitored lamp power is or is not the lamp power of the operation mode # (N + 1). When the result of the determination during the step S7 is YES, the operation mode will be switched during step S8 from the operation mode #N to the operation mode # (N + 1). In addition, during step S9, the lamp power corresponding to the operation mode # (N + 1) will be supplied, which is determined by the power determination part 265 within the lamp power supply part 26-1 (320 W in this case). In step S10, the lamp power in the supply part 26-1 will be controlled by the power regulation part 264, which controls the ON/OFF control of the switch 262, and an impulse signal will be supplied to the monitoring part 263, which has a switch-on cycle for the lamp energy (320 W in this case) corresponding to the operation mode # (N + 1).

During step S11, N is incrementally increased by 1, and during step S12, it will be determined whether N is larger than 4 or not. The process will be returned to step S7 if the determination result during step S12 is NO. In this case, the steps S7 through S11 will be carried out again and an impulse signal will be furnished this time to the monitoring part 263, which has a switch-on cycle corresponding to the lamp power (290 W in this case) according to the operation mode # (N + 1). If the result of the determination during step S12 is then again NO, the process is returned to step S7. The steps S7 through S1 will be carried out again in this case and an impulse signal will be furnished this time to the monitoring part 263, which has a switch-on cycle corresponding to the lamp energy (250 W in this case) according to the operation mode # (N + 1).

When the result of the determination during step S12 is YES, the lamp power supply part 26-1 will be controlled during step S13 so as to turn lamp 23a OFF, or so that an indication is provided with a known means to the user.

With a gradual reduction of the lamp power of the lamp 23a and with a gradual darkening of the screen on the basis of the monitored lamp power, it is thus possible to provide a notice to the user of the projection display apparatus that the end of the operational lifetime of the lamp 23a has almost been reached. By turning the lamp 23a off, when the monitored lamp power is smaller than or equal to a predetermined value, it is further also possible to avoid the worst situation when the lamp 23a explodes or the like. In addition, it is also possible to urge the user to replace the lamp 23a when an indication about a short remaining operational lifetime of the lamp is provided to the user. However, it is also possible for example to provide an indication about a short remaining operational time to the user for a predetermined period of time in order to motivate the user to replace the lamp 23a and then to turn the lamp 23 a OFF.

The following is a description of a second embodiment of the projection display apparatus according to the present invention. The basic construction of this second embodiment can be identical to the basic construction of the first embodiment, which is shown in Fig. 1 and Fig. 2 and the illustration and description can thus be omitted.

**Fig. 6** is a system block diagram which shows an important part of this second embodiment. The parts that are identical to corresponding parts shown in **Fig. 3** are provided with the same reference symbols and their description is omitted.

A control circuit part **31-1**, which is shown in **Fig 6**, contains a microcomputer part **32**, an impulse detector **41**, an impulse level detector **42**, a comparator **43**, an impulse level determination part **44**, an impulse width detector **45**, a comparator **46** and a time determination part **47**. The impulse detector **41** receives lamp current and/or lamp voltage, which are monitored by a monitoring part **263** within the lamp power supply part **26-1**, and detects impulse-formed changes of the lamp current and/or of the lamp voltage. The impulse, which is detected by the impulse detector **41**, is supplied to the impulse level detector **42** and to the impulse width detector **45**.

The impulse level detector **42** detects the level of the detected impulses (hereinafter referred to as impulse level) and supplies the detected impulse level to the comparator **43**. The comparator **43** compares the impulse level which is furnished from the impulse level detector **42** to an impulse level which is furnished by the impulse level determination part **44** and supplies the result of the comparison to the microcomputer part **32**. The impulse level, which is determined in the impulse level determination part **44**, is of a size rendering impulse-forming changes of the lamp current and/or lamp voltage visible as flickering of the lamp **23a**, and it is set for example to 4 V.

On the other hand, the impulse width detector **45** detects the width of the detected impulse (hereinafter referred to as impulse width) and supplies the detected impulse width to the comparator **46**. The comparator **46** compares the impulse width supplied from the impulse width detector **45** to an impulse width supplied from the impulse width determination part **47** and furnishes the result of the comparison to the microcomputer part **32**. The impulse level width, which is determined in the impulse width determination part **47**, is of a size rendering impulse-forming changes of the lamp current and/or lamp voltage visible as flickering of the lamp **23a**, and it is set for example to 1 Hz or more.

On the basis of the result of the comparison, which is supplied by the comparators **43** and **46**, the microcomputer part **32** determines a lamp power which reduces the lamp current and/or the lamp voltage in the power determination part **265** within the lamp power supply part **26-1** if the impulse level, which is detected by the impulse level detector **42**, is greater than the impulse level determined by the impulse level determination part **44**, and if the impulse width, which is detected by the impulse width detector **45**, is greater than the impulse width determined in the impulse width determination part **47**.

**Fig. 7** is a flowchart explaining the operation of these two embodiment forms. Steps corresponding to those of **Fig. 4** are provided with the same reference symbols in **Fig. 7** and their description is omitted.



In the ROM of the microcomputer 32 are stored for example data that are shown in Fig. 8. During the operation mode #1, the impulse level is set to H1, the impulse width is set to W1 and the lamp power is set to 350 W as shown in Fig. 8. Similarly, during the operation mode #2, the impulse level is set to H2, the impulse width is set to W2 and the lamp energy is set to 320 W. During the operation mode #3, the impulse level is set to H3, the impulse width is set to W3 and the lamp energy is set to 290 W. Further, during the operation mode #4, the impulse level is set to H4, the impulse width is set to W4 and the lamp power is set to 250 W.

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To simplify the explanation, Fig. 8 shows a case in which the impulse levels H1 through H4 and the impulse widths W1 through W4 of the lamp current or of the lamp voltage are stored in the ROM. However, it is naturally also possible to store the impulse levels and the impulse widths of the lamp current and/or of the lamp voltage in the ROM [sic].

As shown in Fig. 7, the entire number N is set during step S1-1 to  $N = 1$  when the projection display apparatus is shipped from a plant or when the lamp 23a is replaced. If the result of the determination during step S5 is YES, control is exercised during step S6-1 by the lamp power supply part 26-1 so as to turn the lamp 23a ON with the lamp power of the operation mode # ( $N + 1$ ). During step S7-1, it is determined whether the impulse level and the impulse width of the monitored lamp current and/or of the lamp voltage are or are not the impulse level or the impulse width of the lamp current and/or the lamp voltage of the operation mode # ( $N + 1$ ). If the result of this determination in step S7-1 is YES, the operation mode is switched in step S8 from the operation mode #N to the operation mode # ( $N + 1$ ). With a gradual reduction of the lamp power of the lamp 23a and with a gradual darkening of the screen on the basis of the monitored lamp power, it is thus possible to provide an indication to the user of the projection display apparatus that the end of the operational lifetime of the lamp 23a has almost been reached. By turning OFF the lamp 23a when the monitored lamp flickering is greater than or equal to a predetermined value, it is also possible to avoid the worst situation when the lamp 23a explodes or the like. It is additionally also possible to urge the user to replace the lamp 23a when a notice is provided to the user about a short remaining operation lifetime of the lamp 23a. It is for example also possible to provide a notice to the user about a short remaining operational lifetime of the lamp 23a for a predetermined time period to motivate the user to replace the lamp 23a and then to turn the lamp 23a OFF.

The following is an explanation of a third embodiment of the projection display apparatus according to the present invention. The basic construction of this third embodiment can be the same as the basic construction of the embodiment shown in Fig. 1 and 2 and an illustration and a description thereof is omitted.

Fig. 9 is a system block diagram showing an important part of this third embodiment. The parts corresponding to identical parts that are shown in Fig. 6 are provided with the same reference symbols also in Fig. 9 and a description of these parts is omitted.

This embodiment is equipped with a counter part 49 which is provided within the control switch part 32-2. The results of the comparison made by the comparator 43 and 46 are supplied in this embodiment to this counter part 49 and not to the microcomputer 32. The counter part 49 counts the number of cases in which the impulse level has been detected which can be determined as flickering, and the number of cases when the impulse width which can be determined as flickering has been detected, and supplies the respective count values to the microcomputer part 32.

On the basis of these count values, which are supplied by the counter part 49, the microcomputer 32 determines the lamp power, wherein the lamp current and/or the lamp voltage is reduced, which is determined in the power determination part 265 provided within the lamp power supply part 26-1 based on the number of cases and how often the impulse level, which is detected by the impulse level detector 42, is greater than the impulse level which is determined in the impulse level determination part; wherein a first predetermined number is reached based on the number of these cases; while a second predetermined number is reached depending on how often the impulse width is reached, which is detected by the impulse width detector 45 that is greater than the impulse width determined by the impulse width determination part 47. The first predetermined number and the second predetermined number can have the same value.

Fig. 10 is a flowchart explaining the operation of this third embodiment. The steps which are identical to those that are shown in Fig. 7 and which are provided with the same reference symbols are omitted in Fig. 10.

In this embodiment, during step S1-2, which is indicated in Fig. 10, the counter value of the counter part 49 is reset to 0, the whole number N is set to  $N = 1$  and also the whole numbers I and J are reset to  $I = 0$  and  $J = 0$  when the projection display apparatus is shipped from a plant or when the lamp 23 a is replaced. If the result of the decision during step S5 is YES, the lamp power supply part 26-1 will be controlled during step S6-2 in order to turn the lamp 23a ON with the lamp power of the operation mode #  $(N + 1)$  and the counting operation of the counter part 49 will be started.

During step S7-1 it is determined whether the impulse level and the impulse width of the monitored lamp current and/or of the lamp voltage is or is not the impulse level or the impulse width of the lamp current and/or of the lamp voltage of the operation mode #  $(N + 1)$ . If the result of this decision during step S7-1 is YES, it will be determined during step S21 whether the whole number I has or has not reached a predetermined number X and whether the whole number J has or has not reached a predetermined number Y. The process is returned back to step S7-1 if the result of the decision in step S21 is NO. On the other hand, if the result of the decision in step S21 is YES, the operation mode will be switched

during step S8 from the operation mode # N to the operation mode # (N + 1).

The following is a description of a fourth embodiment of the projection display apparatus according to the present invention. The basic construction of this fourth embodiment can be identical to the basic construction of the first embodiment shown in Fig. 1 and Fig. 2 and the illustration and description are omitted.

Fig. 11 is a system block diagram which shows an important part of this embodiment. The parts corresponding to identical parts that are shown in Fig. 3 are provided with the same reference symbols also in Fig. 11 and a description of these parts is omitted.

This embodiment is equipped with a microcomputer part 32, a sensor 51, a voltage converter 52, an impulse detector 53, a comparator 54 and a determination part 55 deployed within a control circuit part 31-3. The sensor 51 has a known construction for detection of at least one of the items including the intensity of the lamp illumination, the lamp temperature, the lamp emission spectrum, the lamp color temperature and the lamp emission color coefficient. To simplify the explanation, it will be assumed that the sensor 51 detects the intensity of the lamp illumination in this embodiment.

The voltage converter 52 converts the lamp illumination intensity, which is detected by the sensor 52, to a corresponding voltage and furnishes this voltage to the impulse detector 53. The impulse detector 53 is constructed so as to detect the output voltage of the converter 52 in the form of an impulse when the sensor 52 detects that flickering has been generated.

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An output impulse of the impulse detector 53 is supplied to the comparator 54 and compared to the impulse level and/or to the impulse width, which is supplied from the determination part 55. The result of the comparison is supplied by the comparator 54 to the microcomputer 32.

On the basis of the result of the comparison, which is supplied by the comparator 54, the microcomputer 32 determines the lamp power by which the lamp current and/or lamp voltage is reduced in the power determination part 265 within the lamp power supply part 26-1 if the impulse level and/or the impulse width, which is/are detected by the impulse detector 53, is/are greater than the impulse level and/or the impulse width, which is determined in the determination part 55.

Fig. 12 is a flowchart explaining the operation of this fourth embodiment. The steps which are identical to corresponding steps shown in Fig. 4 are provided with the same reference numbers and their explanation is omitted.

In the ROM of the microcomputer part 32 are stored for example the data shown in Fig. 13. During the operation mode #1, as shown in Fig. 13, the impulse level is set to h1, the impulse width is set to w1 and the lamp power is set to 350 W. Similarly, during the operation mode #2, the impulse level is set to h2, the impulse width is set to w2 and the lamp power is set to 320 W. During the operation mode #3, the impulse level is set to h3, the impulse width to w3 and the lamp power is set to 290 W. Further, during the operation mode #4, the impulse level is set to h4, the impulse width to w4 and the lamp power is set to 250 W. To simplify the explanation, Fig. 12 indicates a case when the impulse levels set to h1 through h4, and the impulse widths set to w1 through w4 for voltage, corresponding to the intensity of the lamp illumination, are stored in the ROM. However, it is naturally also possible to store the impulse levels and/or the impulse width of the voltage in the ROM which correspond to at least to one of the elements comprising the intensity of the lamp illumination, the lamp emission spectrum, the lamp color temperature and the lamp emission color coefficient.

In this embodiment, the whole number N is set in step S1-3, which is shown in Fig. 12, to  $N = 1$  when the projection display apparatus is shipped from a plant or which the lamp 23a is replaced. If the result of the determination in step S5 is YES, the lamp power supply 26-1 will be controlled during step S6-3 so as to turn the lamp 23a ON with the power of the operation mode # ( $N + 1$ ). During step S7-3, it is determined whether the impulse level and/or the impulse width of the voltage, which corresponds to the detected lamp illumination intensity, is/are or are not the impulse level and/or the impulse width of the voltage corresponding to the lamp illumination intensity of the operation mode # ( $N + 1$ ).

With a gradual reduction of the lamp power of the lamp 23a and with a gradual darkening of the screen on the basis of the lamp flickering, which is detected from the lamp illumination intensity, it is thus possible to provide a notice for the user of the projection illumination apparatus that the operation lifetime of the lamp 23a has almost come to its end. By turning the lamp 23a OFF when the detected lamp flickering is greater than or equal to a predetermined value, it is further also possible to prevent the worst situation, namely when the lamp explodes or the like. In addition, it is also possible to urge the user to replace the lamp 23a by providing an indication to the user about the short remaining operational lifetime of the lamp 23a. It is for example also possible to indicate the short remaining operational lifetime of the lamp 23a to the user for a predetermined period of time in order to motivate the user to replace the lamp 23a and then to turn the lamp 23a OFF.

The flickering can be detected on the basis of the voltage, which corresponds at least to the one of the elements including the intensity of the lamp illumination, the lamp temperature, the lamp emission spectrum, the lamp color temperature and the lamp emission color coefficient. In this description, however, the explanation of the detection of the flickering on the basis of the voltage is omitted, since correspondence to the lamp temperature, lamp emission spectrum, the lamp color temperature and the lamp emission color coefficient, corresponding to the flickering, can be detected similarly to the above-described detection of flickering on the basis of voltage which corresponds to the intensity of lamp illumination.

The next description explains a fifth embodiment of a projection display apparatus according to the present invention. The basic construction of this fifth embodiment can be identical to the basic construction of the first embodiment shown in Fig. 1 and Fig. 2 and the illustration and description is thus be omitted.

Fig. 14 is a system block diagram which shows an important part of this second embodiment. The parts that are identical to corresponding parts shown in Fig. 3 are provided with the same reference symbols and their description is omitted.

To simplify the explanation, Fig. 14 shows only the parts which are relevant for providing an indication to the user. In reality, the data of the counter 33, of the comparator 43, of the counter 49 and of the comparator 54 and the like are status signals indicating the status of the lamp 23a, such as the operational lifetime of the lamp 23a, reduction of the lamp power and the generation of flickering of the lamp 23a, supplied to the microcomputer part 32.

The parts contained in Fig. 14 relating to providing an indication to the user comprise a screen controller 61, a control circuit 62, a control panel 63, an audio circuit 64 and a speaker 65. The screen controller 61 creates with the control circuit 62 and with the control panel 63 used with a display an indication means (hereinafter referred to as a display indication means). On the other hand, the audio circuit 64 and the speaker 65 create an indication means using sound or speech (hereinafter referred to as audio indication means). It is naturally also possible to provide only one of the means available as the display indication means and as the audio indication means.

When the microcomputer 32 determines from the received status signals that the ON time of the lamp 23a in the case of the first embodiment has reached 900 hours or 1,000 hours, or that the monitored lamp power was reduced to 290 W or 250 W, the microcomputer 32 instructs the indication means to provide an indication for the user. With the display indication means, the microcomputer part 32 issues an indication from the control circuit 62 to the screen part 61, which informs about the imminent end of the operational lifetime of the lamp 23a, and further supplies a display instruction to the control circuit 62. Therefore, the control circuit 62 will display the instruction on the screen 61 at the control panel 63. With the audio indication means, the microcomputer part 32 has another effect, by causing the audio circuit 64 to supply an indication to the speaker 65, which informs that the operational lifetime of the lamp 23a is almost at its end. In this case, the indication, which is provided through the audio indication means, can be provided as an alarm sound or as a voice instruction.

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Even if the user himself fails to notice that the power of the lamp 23a has been gradually

reduced and the screen is becoming gradually darker, in order to provide a notice for the user that the operation lifetime of the lamp 23a is almost at its end, it is therefore possible to provide a definitive notice for the user with the indication which is provided through the display indication means and/or the audio indication means that the operational lifetime of the lamp 23a is almost at its end.

The following is a description of a sixth embodiment of the projection display apparatus according to the present invention. Fig. 15 is a system block diagram showing an important part of this sixth embodiment. The parts shown in Fig. 15, which are the same as the corresponding parts of Fig. 1 and 3, are provided with the same reference symbols and a description of these parts is omitted. The basic construction of this sixth embodiment can be the same as the basic construction of the first embodiment shown in Fig. 1 and 2 and the illustration and description thereof will be omitted. Fig. 16 is a diagram showing the basic construction of this sixth embodiment, and Fig. 17 is a diagram which shows the mechanism of a lamp cooling part of this sixth embodiment.

To simplify the explanation, Fig. 15 shows only the parts which are relevant to ventilators 24 and 25 and a cooling part for the lamp 23a. In reality, the data of the counter 33, the comparator 43, the counter part 49 and the comparator 54, are status signals indicating the status of the lamp 23a, such as the operational lifetime of the lamp 23a, or reduction of the lamp power and generation of flickering of the lamp 23a, supplied to the microcomputer part 32.

In Fig. 15, the cooling part for the lamp 23a contains a cooling opening motor controller 71, a motor 72, a controller 74 for an angular-gear motor operated by an air current, and a motor 75. When the microcomputer part 32 determines from the received status signal that the ON time of the lamp 23a in the case of the first embodiment has reached 900 hours or 1,000 hours or that the monitored lamp energy has been reduced to 290 W or 250 W, the microcomputer part 32 will indicate an intensive cooling mode. During the intensive cooling mode, control is exercised in order to realize more intensive cooling at least with ventilators 24 and 25 of the cooling which is carried out via the air current guide 82, shown in Fig. 16.

When more intensive cooling is conducted, which is realized with the ventilators 24 and 25, the microcomputer part 32 increases the rotational speed of the ventilators 24 and 25. When the cooling is intensified, which is implemented through the cooling opening 81, the microcomputer part 32 controls the motor 72 through the cooling opening motor controller 71 so as to increase the opening size of the cooling opening 81. When the cooling is further intensified, which is carried out via the air current guide 82, the microcomputer part 32 controls the motor through the air current guide motor controller 74 so as to increase the angle of the air current guide 82 in a direction enabling to increase the cooling efficiency.

A movable member 83A is provided on a wall which defines the cooling opening 81 as shown in Fig. 17. This movable member 83A is movable in the direction indicated by the arrows. When the microcomputer part 32 controls the motor 72 via the cooling motor

opening controller 71 to increase the cooling opening 81, the movable member 83A is thus moved upward in order to increase the size of the opening.

Additionally, a pair of guide plates is provided, which form an air current guide 82, on the base 21. The pair of the guide plates of the air current guide 82 is supported so that they can be rotated around the center of rotations 93 and shifted in the directions indicated by the arrows. One of the guide plates of the air current guide 82 contacts a pin 91, which is rotated by a motor 75, and thus adjusts the angle of the air current guide 82 depending on the rotation position of the pin 91. When the microcomputer part 32 controls the motor 75 through the air current guide motor controller 74 in order to steer the angle of the air current guide 82 in a direction that intensifies the cooling, the result is that the guide plates of the air current guide 81 are turned in directions separating the plates from each other so as to increase the cooling effect.

When the operational lifetime of the lamp 23a is almost at its end, according to this embodiment, the cooling of the lamp 23a is intensified in order to reduce generation of heat by the glass tube of the lamp 23a. For this reason it is possible to extend the operational lifetime of the lamp 23a, and an indication can be provided to the user about the operational lifetime of the lamp 23a according to any of the above described embodiments one to five, before breaking or a similar status of the lamp 23a in fact occurs.

It is naturally also possible to combine at will two or more embodiments described above as embodiment one through embodiment six. In addition, the lamp power can be also changed continuously or intermittently in stages.

Further, the present invention is not limited only to these embodiments, since various changes and modifications can be anticipated without deviating from the protected scope of the present invention.

#### Patent Claims

1. A projection display apparatus provided with a discharge lamp, **characterized by the fact** that it is equipped with:  
a detector, which detects the lamp energy of the discharge lamp on the basis of predetermined information; and  
a controller, which controls the discharge lamp on the basis of the detection result of the detector in order to change the lamp energy.
2. Projection display apparatus according to claim 1, characterized by the fact that:  
the predetermined information contains at least information which is selected from a group comprising accumulated ON time, a lamp current, a lamp illumination intensity, a lamp temperature, a lamp emission spectrum, a lamp color temperature and a lamp emission color coefficient of the discharge lamp;  
wherein the controller controls the discharge lamp in order to reduce the lamp power when

the result of the detection indicates that information corresponding at least to a predetermined value has been reached.

3. Projection display apparatus according to claim 1, characterized by the fact that: the predetermined information indicates at least information which is selected from a group comprising a lamp current and/or a lamp voltage, a lamp temperature, a lamp emission spectrum, a lamp color temperature and lamp emission color coefficient of the discharge lamp; and the controller controls the discharge lamp in order to reduce the lamp power when the detection result of the detector indicates the change of at least one of the information items occurred within a predetermined time period.

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4. Projection display apparatus according to claim 1, characterized by the fact that: the predetermined information indicates a change of at least one of the information items, which is selected from a group comprising a lamp current and/or a lamp voltage, a lamp temperature, a lamp emission spectrum, a lamp color temperature and a lamp emission color coefficient of the discharge lamp; and the controller controls the discharge lamp in order to reduce the lamp power when the detection result of the detector indicates the change of at least one of the information items which is greater than or equal to a predetermined width.

5. Projection display apparatus according to any of the claims 1 through 4, further characterized by an indication part, which issues an indication on the basis of the detection result of the detector.

6. Projection display apparatus according to any of the claims 1 through 5, further characterized by the fact that the controller comprises a means enabling to turn the discharge lamp forcibly OFF on the basis of the detection result of the detector.

7. Projection display apparatus according to any of the claims 1 through 6, further characterized by a cooling means for cooling of the discharge lamp, wherein the controller of the cooling means is controlled on the basis of the detection result of the detector.

8. Projection display apparatus according to any of the claims 1 through 7, further characterized by the fact that the controller changes the lamp power continuously.

9. Projection display apparatus according to any of the claims 1 through 7, further characterized by the fact that the controller changes the lamp power intermittently.

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15 Pages of Drawings Enclosed

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FIG. 1

FIG. 2

FIG. 3

23a	lamp
261	input part
263	monitoring part
264	power regulation part
265	power determination part
266	igniter
32	microcomputer part
33	counter

FIG. 4

S1	reset counter, $N = 1$	
S2	main power in	
S3	read ROM data	
S4	ready	
S5	ON/OFF switch is ON?	NO
	YES	
S6	lamp ON, start the counter	
	NO	
S7	power of mode # ( $N + 1$ )?	
	YES	
S9	power output corresponding to mode # ( $N + 1$ )	
S10	output of an impulse with a switch-on cycle corresponding to the power	
S12	NO	YES
S13	lamp OFF/indication	
	END	

FIG. 5

Operation Mode	ON Time	Power
#1	0 h	350 W
#2	700 h	320 W
#3	900 h	290 W
#4	1,000 h	250 W

FIG. 6

23a lamp  
 261 input part  
 263 monitoring part  
 264 power regulation part  
 265 power determination part  
 266 igniter  
  
 32 microcomputer  
 44 impulse level determination part  
 43 comparator  
 46 comparator  
 47 time determination part  
 42 impulse level detector  
 45 impulse width detector  
 41 impulse detector

FIG. 7

S2 main power ON  
 S3 read ROM data  
 S4 ready  
 S5 ON/OFF switch ON? NO  
     YES  
 S6-1 lamp ON  
     NO  
 S7-1 impulse level & impulse width of mode # (N + 1)?  
     YES  
 S9 power output corresponding to mode # (N + 1)  
 S10 output of an impulse with a switch-on cycle corresponding to the power  
 S12 NO YES  
 S13 lamp OFF/indication  
     END

FIG. 8

Operation Mode	Impulse Level	Impulse Width
#1	H1	W1
#2	H2	W2
#3	H3	W3
#4	H4	W4

FIG. 9

23a lamp  
 266 igniter  
 263 monitoring part  
 261 input part  
 264 power regulation part  
 265 power determination part  
 32 microcomputer part  
 49 counter  
 44 impulse level determination part  
 43 comparator  
 46 comparator  
 47 time determination part  
 42 impulse height detector  
 45 impulse width detector  
 41 impulse detector

FIG. 10

S1-2 reset counter,  $N = 1$ ,  $1 = 0$ ,  $J = 0$   
 S2 main power ON  
 S3 read ROM data  
 S4 ready  
 S5 ON/OFF switch ON? NO  
     YES  
 S6-2 lamp on, start counter  
     NO  
 S7-1 impulse level and impulse width of mode #  $(N + 1)$ ?  
     YES NO  
 S9 power output corresponding to mode #  $(N + 1)$   
 S10 output of an impulse with a switch-on cycle corresponding to the power  
     NO

S13 YES  
lamp OFF/indication  
END

## FIG. 11

23a lamp  
266 igniter  
263 monitoring part  
261 input part  
264 power regulation part  
265 power determination part  
32 microcomputer part  
54 comparator  
53 impulse detector  
52 voltage converter  
51 sensor  
55 determination part

## FIG. 12

S2 main power ON  
S3 read ROM data  
S4 ready  
S5 ON/OFF switch ON? NO  
YES  
S6-3 lamp ON  
NO  
S7-3 impulse level & impulse width of mode # (N + 1)?  
YES  
S9 power output corresponding to mode # (N + 1)  
S10 output of an impulse with a switch-on cycle corresponding to the power  
S12 NO  
YES  
S13 lamp OFF/indication  
END

FIG. 13

Operation Mode	Impulse Level	Impulse Width
#1	H1	W1
#2	H2	W2
#3	H3	W3
#4	H4	W4

FIG. 14

STATUS SIGNALS →

32 MICROCOMPUTER PART  
61 SCREEN CONTROLLER  
62 CONTROL CIRCUIT  
63 CONTROL PANEL  
64 AUDIO CIRCUIT  
65 SPEAKER  
→ TO LAMP POWER SUPPLY PART 26-1

FIG. 15

STATUS SIGNALS →

32 MICROCOMPUTER PART  
24 VENTILATOR  
25 VENTILATOR  
  
TO LAMP POWER SUPPLY PART 26-1

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FIG. 16

FIG. 17